EPIC Strategic Goals

Built Environment

Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

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California's Electric Program Investment Charge (EPIC) program is funded by California utility customers under the auspices of the California Public Utilities Commission.

This report was completed by The Accelerate Group, a consultant to the California Public Utilities Commission and the Project Coordinator for the EPIC Policy + Innovation Coordination Group. The information herein was collected and summarized by the Project Coordinator, with input from members of the EPIC Policy + Innovation Coordination Group and does not reflect an official position of the California Public Utilities Commission.

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I. EXECUTIVE SUMMARY

In its most recent EPIC decision,[1] the California Public Utility Commission (CPUC) directed that program-wide goals are needed to evaluate the progress of innovation investments and the extent to which investment plan portfolios maximize ratepayer benefits and impacts in achieving California's clean energy and climate goals. As part of that decision, the CPUC directed the establishment of a public workshop process to inform how Strategic Goals and Objectives should be articulated and established by the Commission in its next guidance Decision for the EPIC 5 cycle (2026-2030). The overall goal of the Strategic Goals Workshop process is to collect stakeholder input on critical pathways, gaps, roles and outcomes in achieving the State's climate goals that would be best fulfilled by EPIC's research, development, and demonstration (RD&D) funding, considering its unique role and opportunities.

On September 19, 2023, the CPUC hosted the EPIC Strategic Goals Built Environment Workshop, which focused on a selection of critical pathways and topic areas related to grid modernization that were discussed in the Kick-Off Workshop, including Customer Focused Solutions, Building Decarbonization, Electrification, and the Coordinated Role of Gas.

One hundred and twenty stakeholders participated in the workshop. Within the critical pathways for built environment, participants highlighted the following key gaps and opportunities for EPIC research: greater demand flexibility from electrified buildings; phasing out gas infrastructure in a planned manner on a larger scale, like neighborhood level; studying customer behavior and identifying cost reduction opportunities to enable greater clean appliances adoption, retrofits and greater demand flexibility; and scaling up electrification and retrofits efforts though standardization of interconnection, technology, data sharing, and permitting requirements. Participants noted that EPIC can play a key role in deploying technologies at greater scale, coordinating various programs to enable greater synergies and data sharing, and targeting most vulnerable neighborhoods in the most polluted areas.

[1] CPUC Decision (D.)23-04-042

II. BACKGROUND

What is EPIC?

The EPIC program is funded by California utility customers under the auspices of the California Public Utilities Commission.

The Electric Program Investment Charge (EPIC) is a California ratepayer funded program that drives efficient, coordinated investment in new and emerging clean energy solutions. Its mandatory guiding principle is to provide ratepayer benefits, with a mission of investment in innovation to ensure equitable access to safe, affordable, reliable, and environmentally sustainable energy for electricity ratepayers. EPIC invests in a wide range of critical innovation, including building decarbonization, cybersecurity, demand reduction, distributed energy resource integration, energy storage, entrepreneurial ecosystems, grid decarbonization, grid decentralization, grid modernization, grid optimization, grid resiliency and safety, high penetration renewable energy grid integration, industrial and agricultural innovation, smart grid technology, transportation electrification, and wildfire mitigation. From 2012 through 2030, EPIC will have invested nearly $3.4 billion in clean energy technology innovation.

What is the Policy + Innovation Coordination Group?

The California Public Utilities Commission (CPUC) oversees and monitors the implementation of EPIC research, development, and deployment program. For current EPIC funds from investment periods 1 (2012-2014), 2 (2015-2017), 3 (2018-2020), and 4 (2021-2025) there are four program administrators: the California Energy Commission (CEC), Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). The CEC administers 80% of the funds and the utilities administer 20%.

In Decision 18-10-052, the CPUC established the Policy + Innovation Coordination Group (PICG)—comprised of a Project Coordinator, the four Administrators, and the CPUC—to better align EPIC investments and program execution with CPUC and California energy policy needs. In Decision 23-04-042, the CPUC directed PICG to convene the Strategic Goals and Objectives process to inform Commission guidance on the EPIC 5 funding cycle (2026-2030).

Workshop Process Goals

The Strategic Goals Workshop Process will focus on identifying four core elements:

Pathways:

Set of critical actions necessary to support meeting the State's 2045 zero carbon goals via the most effective strategies and technology innovation.

Gaps:

Key challenges for achieving zero carbon goals and how RD&D should be prioritized to address opportunities and barriers more quickly along critical pathways.

Roles:

The best-positioned stakeholders (ratepayers, state, federal, private sector) to lead innovation investment in addressing identified gaps, including through coordination and collaboration.

Outcomes:

Clear, measurable, and reasonable targets to be used by administrators in developing EPIC portfolios and used in program evaluations to measure impacts of EPIC in supporting achievement of California's 2045 zero carbon goals.

III. WORKSHOP SUMMARY

Agenda

The Workshop was hosted on September 19, 2023, from 10 am – 4:15 pm and consisted of two roundtables. The stakeholder discussions following each roundtable welcomed questions and comments from the audience in the room and participants connected virtually. CPUC Commissioner Genevieve Shiroma provided opening and closing remarks. The PICG Project Coordinator provided an initial introduction to the Workshop Process and the purpose of the event.

Opening and Closing Remarks: Commissioner Genevieve Shiroma welcomed workshop participants and outlined workshop goals. The Commissioner noted that California is experiencing a big paradigm shift from gas to all electric buildings, employing new technologies, such as heat pumps and induction stoves. The Commissioner noted that research can play an important role in making home appliances more efficient and strengthening electric grid to sustain the increased load from building electrification. She

stressed the importance of the input from the workshop stakeholders in defining goals and strategies for EPIC funded research to help California reach its decarbonization goals. In the closing remarks, Commissioner Shiroma noted the importance of finding synergies through EPIC and other proceedings. Commissioner Shiroma thanked the participants and noted that she is very inspired by the workshop discussions.

Roundtables: The two roundtables focused on the following areas:

I. Customer Focused Solutions.

Presenters:

- Elden Hawkes Jr., U.S. Small Business Administration Office of Innovation and Technology (SBA)
- Ethan Elkind, University of California (UC), Berkeley
- Michael Colvin, Environmental Defense Fund (EDF)
- Carmen Best, Recurve
- Joe Desmond, California Efficiency + Demand Management Council (CEDMC)
- Jared Langevin, Lawrence Berkeley National Laboratory (LBNL)
- Brett Webster, Rocky Mountain Institute (RMI)

During the roundtable, a presentation from SBA outlined federal funding available under the SBA America's SeedFund Program for small American innovative manufacturing businesses. UC Berkeley presented findings from their recent "Building Towards Decarbonization" report and "The Future of California Consumer Energy Finance" report, noting that an incentive-based approach proved to be ineffective, and more financing solutions are needed to support retrofits and building decarbonization. Recurve discussed research data transparency and tracking and suggested focusing EPIC research on data-driven tools, like the CPUC Distributed Energy Resources (DER) Avoided Cost Calculator, which can provide valuable data to inform customer, grid operator, and industry decisions. CEDMC discussed barriers to smart devices adoption and areas where EPIC research can be most valuable in addressing those barriers. LBNL discussed findings from the LBNL/Brattle Group "Buildings 2050" study on scenarios of building and grid decarbonization on a national level, noting that the US buildings sector can reduce up to 90% of carbon emissions by 2050 through energy efficiency, flexible load and decarbonization of electric supply. RMI presented findings from their REALIZE Initiative on building retrofit acceleration through standardized solutions. The presenters also discussed approaches to ensure electrification affordability and the importance of developing Energy Burden targets for California. They noted that Energy Burden, Air Quality, and Building Safety metrics need to be incorporated into all programs to measure their success in bringing real benefits to customers. Stakeholder discussion following the presentation identified key targets that can be potential strategic goals for EPIC

portfolio. Participants also discussed the unique role of EPIC and highlighted several areas where EPIC can play a key role, including deploying technologies at scale, targeting most vulnerable communities, enabling seamless data sharing, and coordinating between programs, platforms, and policies for grater synergies.

II. Building Decarbonization, Electrification, and the Coordinated Role of Gas.

Presenters:

- Beckie Menten, Building Decarbonization Coalition (BDC)
- Zach Lou, California Green New Deal Coalition (CA GND)
- Andrew Brooks, Association for Energy Affordability (AEA)
- Jacques de Chalendar, Stanford University
- Kelly Lyndon, San Diego 350 Climate Action (SD 350)
- Daniel Hamilton, City of Oakland
- Theo Caretto, Communities for a Better Environment (CBE)
- Peter Chen, California Energy Commission (CEC)
- Mark Toney, The Utility Reform Network (TURN)

During the roundtable, BDC discussed a neighborhood decarbonization approach to transition neighborhoods off the gas infrastructure and opportunities presented by neighborhood-scale geothermal networks. CA GND discussed findings of their recent Report on equitable building decarbonization, noting that decarbonization is also a housing issue in California, where housing stock is one of the oldest and deteriorated in the country, and where 46% homes are occupied by renters. CA GND also shared findings from the California Housing Partnership report that shows that the need for affordable housing is much greater than available affordable housing. The naturally occurring affordable housing is shown to represent about a third of California's affordable housing. CA GND noted that typically it is affordable because of its poor and unsafe conditions. Building decarbonization improves building conditions and can lead to decreased availability of naturally occurring affordable housing. BDC and AEA discussed key barriers to multi-family housing decarbonization projects that can benefit from EPIC research, including developing more renter-ready appliances, like cook stove and water heater appliances with integrated batteries, and looking into panel optimization and smart panels to remove the need for upgrades to building electric wiring. Stanford's presentation discussed the RD&D needs in commercial building electrification, noting that 92% of the energy load comes from medium to large commercial buildings that are above 5,000 sq.f., like schools, hotels, supermarkets, and offices, even though they only constitute 50% of the buildings in the US. The Stanford presenter mentioned that 40% of commercial floor space has building automation systems

for heating or cooling and only 22% of the buildings have programmable thermostats, with only 6% internet connected thermostats. SD 350 highlighted metrics and gaps for supporting building electrification with equity in mind, noting the need to keep electricity cheaper than gas, aligning utility incentives with decarbonization goals, and setting simple trackable key metrics, like target cost per kWh. The City of Oakland presenter highlighted the need to simplify building codes to ease interconnection and contractors' ability to follow their requirements. He also focused on the need for strategic planning and mapping out transmission and distribution constraints to help cities align their strategic planning with existing system conditions. CBE discussed opportunities and challenges for hydrogen use, noting that over 90% of hydrogen today is produced from fossil fuel resources and can extend the lifespan of polluting resources, which perpetuates the disproportionate negative impacts on low-income and Environmental and Social Justice (ESJ) communities. CBE also noted that hydrogen use has unclear benefits for ratepayers and can increase infrastructure costs. The CEC discussed programs for commercialization of clean hydrogen for industrial decarbonization, noting that 20% of state emissions come from industry. The CEC further noted that decarbonizing high heat processes provides the best opportunities for clean hydrogen, like cement, glass, metal, and electronics manufacturing. The CEC noted that no clean hydrogen production facilities are currently present in California due to the high costs of clean hydrogen production. TURN noted that power should be treated as an essential human right and discussed how to protect captive customers. TURN recommended funding an independent study on gas system decommissioning. TURN also called on the Commission to freeze funding for hydrogen research until 100% clean hydrogen can be guaranteed, and instead called for a focus on geothermal heat pump technology that is 44% more effective in reducing emissions and energy use. In the stakeholder discussions following the presentations, participants discussed using the neighborhood-scale decarbonization approach in EPIC strategic goals and streamlining interconnection and permitting by enabling a better visibility into the transmission and distribution grid infrastructure capacity and constraints. Participants also discussed opportunities to reduce costs of geothermal resources and approaches to decommission or reuse gas pipeline systems.

Presentations

The link to each presentation is included in the Appendix to this report.

Attendees

One hundred and twenty individuals participated in the workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma and CPUC Staff, representatives from the US Small Business Administration (SBA) Office of Innovation and Technology, the four Administrators of the EPIC Program (California Energy Commission (CEC), and the three utilities), as well as research institutions, community leaders, technology solution providers, government entities, utilities, non-governmental organizations, and industry.

IV. STAKEHOLDER RECOMMENDATIONS

Workshop participants provided the following recommendations for EPIC-funded research opportunities that can address key gaps identified during the workshop:

Key Items of General Consensus

Workshop discussions and presentations highlighted the following key areas of consensus among workshop participants:

Critical Pathways:

The discussions focused on the three main pathways of built environment and electrification, identified in the previous workshops: Customer Focused Solutions, Building Decarbonization and Electrification, and Coordinated Role of Gas. No new pathways were suggested during this workshop. Many equity considerations were raised generally and related to specific pathways, that are addressed below.

Key Gaps:

Overall, the participants agreed that enabling greater demand flexibility from residential and commercial buildings is a key to unlocking the potential of electrified buildings to reduce and delay grid upgrades and significantly reduce costs of decarbonization and transition to 100% clean energy grid. Understanding customer behavior in technology adoption and demand flexibility, how customers react to signals and incentives and what motivates them was noted as a key gap that can benefit the most from EPIC research. Participants also agreed that the scale of electrification and retrofits that is needed to reach California climate goals cannot be achieved with available state funding, and it is crucial to find ways to significantly reduce costs and find synergies between programs and private and federal funding to be able to scale up. Participants agreed overall that EPIC can play a key role in

streamlining and reducing costs of installation, interconnection, and permitting by helping standardize interconnection, technology, retrofits, building codes and data sharing requirements, and enable more efficient planning through enabling greater data access and visibility into the transmission and distribution systems conditions.

Unique Role of EPIC:

Participants agreed overall that, as a ratepayer-funded resource, EPIC is best suited to fund research on the following: 1) reducing financial burden of energy bills (Energy Burden) for California communities; 2) achieving a rate of building decarbonization retrofits at the scale that is needed for economy-wide decarbonization; 3) rapidly expanding capacity of flexible load needed for California's grid balancing needs; 4) larger scale targeting and demonstrations, like neighborhood-scale approach in gas phase out, retrofits and appliances adoption; 5) targeting the most vulnerable populations, particularly in the most polluted areas; 6) enabling seamless data flow and sharing between various platforms, programs, and entities; and 7) coordinating between different programs to understand how to fit them together to complement each other and provide holistic wrap-around benefits for customers and communities.

Desired Outcomes & Quantitative Targets:

Stakeholders identified opportunities for quantitative targets in the following areas:

- **Flexible Load:** Deploy 7 GW of flexible load by 2030, including VPPs, and relying on energy efficiency, load shifting, and electrification to provide 50% of building emission reductions;
- **Retrofits:** Increase rate of retrofits to 3% annually and 3.6% for affordable housing, and greatly reducing retrofit costs, including reducing costs of geothermal heat pumps installation, to about $20,000 per home;
- **Energy Burden:** Reduce Energy Burden for low-income customer to the EPIC identified numbers, but overall, much greater than the current 9% and closer to the national average of 3%, and keep electricity bills lower than gas bills;
- **Air Quality:** Improve air quality in most polluted areas through retrofits and electrification efforts by targeting these areas first;
- **Safety:** Increase the number of safe and code compliant buildings through retrofit efforts.

Other potential targets suggestions included:

- cost to go down to $X per kWh;
- % of all buildings electrified;
- % of buildings using distributed solar; and
- % of gas pipeline miles decommissioned.

Desired Outcomes and Targets

Specific suggestions of the potential targets for EPIC research suggested during this workshop included the following:

#1: Target: Flexible Load and Load Shifting.

- **7 GW of flexible load by 2030**: LBNL noted that about 200 GW, or about 15-20%, of flexible load is needed nationally, according to LBNL modelling and NREL's Electrification Futures studies, to relieve grid constraints. LBNL noted that not all this flexible load has to be dispatchable, because energy efficiency and load shifting can play a critical role as well. For California, CEDMC noted that CEC recently published its recommended target of 7,000 MW of load shifting by 2030, in line with California Senate Bill 846 that sets load shifting mandates for California. CEC estimated load shifting capability in 2022 at 3,100 to 3,600 MW, which totals about 3,400 to 3,900 MW of new load shifting by 2030.
- **X number of VPPs by 2030**: Recurve noted that US Department of Energy Loan Programs Office (USDOE LPO) released its Pathways to Commercial Liftoff Reports which estimates energy consumption in the US to double or triple within the next 10 years and estimate a target of 80-160 GW of virtual power plants (VPPs) by 2030 nationwide, triple of the current adoption rate. California could develop a state-specific target of that national goal.
- **Capturing additional margin from energy efficiency opportunities**: Recurve noted that over the course of a year, their market access program for summer reliability solutions was able to capture 38% more than the existing energy efficiency portfolio in system value. Recurve noted that this shows that there is a lot of potential available that can be captured with the right price signals to optimize the load.
- **50% of California's buildings emissions reduction target to come from building efficiency, electrification, and demand flexibility and cut costs of grid decarbonization by one third**: LBNL noted that buildings have high potential to serve as a demand side resource, since buildings consume about ¾ of electricity nationally. LBNL noted that there are three types of building solutions: 1) reducing building demand through energy efficient equipment and building envelopes; 2) building demand flexibility through shedding, shifting and reshaping buildings electric loads and behind the meter resources; and 3) buildings end use electrification through converting fossil fired cooking and water/air heating and cooling to electric use. In addition, decarbonization of the electricity generation powering the grid reduces buildings' overall carbon footprint as well. Most studies highlight that

building electrification paired with decarbonization of electric supply are key to reach net zero emissions by 2050. However, LBNL/Brattle Group "Buildings 2050" study noted that, from the energy savings and emission reduction perspective, parallel improvements in demand side efficiency and flexibility are as critical as energy efficiency and electrification. This is particularly relevant in the near term, while the grid is still decarbonizing its energy supply. The "Buildings 2050" study shows that 92% of building emissions can be reduced nationally by 2050, with almost 50% of that attributed to demand side efficiency and electrification, and the other half to electric supply decarbonization. Building efficiency and demand flexibility can avoid up to ⅓ of the costs of grid upgrades, amounting to more than $100 billion nationally by 2050. Increased building efficiency and flexibility can also further reduce costs by reducing existing buildings' load to make room for new load from electrification.

#2: Target: Retrofits.

- **3% retrofit rate for residential and 2% for commercial buildings, and 3.6% for affordable housing:** RMI noted that to meet California's climate goals the retrofit rate must increase 3 to 5 times. According to the UC Berkeley presenter, California has about 14 million existing residences, including homes and units in multifamily homes. Many will need retrofits. RMI presented the Advance Building Collaborative's Market Guidance Report that shows that for California's 4.3 million units of multi-family building stock, about ¾, totaling almost 3 million units, will need an all equipment swap out; while about ¼, which totals about 1 million units, will need equipment swaps paired with light touch envelope. A smaller fraction of buildings, about 82 thousand units, require more aggressive envelope upgrades. Only about 220 thousand units do not require upgrades now. LBNL also noted that their research suggests a target of 3% retrofit rate for residential and 2% for commercial buildings by 2030 nationwide under the best-case scenarios, which is about 4 million homes nationally, representing about 3.3 to 3.4 times increase to current rates. RMI noted that for California's affordable housing of 1.3 million units of natural affordable and 0.5 mil of subsidized housing they estimate a target retrofit rate to be 3.6% a year, or about 45,000 units a year.
- **Decrease retrofit costs, mandate geothermal heat pumps for new build, and reduce costs for retrofits to $20,000 per home:** UC Berkeley noted that the current level of available funding is not sufficient to support the required scale of retrofits. For example, it took GoGreen Financing over the last six years and cost $55 million to issue 3,000 residential retrofit loans. However, about $26 billion will need to be invested through 2030 under the CEC "moderate electrification scenario." About $150

billion investment is needed by 2030 for space and water conditioning, according to the BDC estimates. Several participants, including BDC, AEA, and TURN, highlighted the high potential of ground-based geothermal heat pump technology, particularly if deployed on a neighborhood or district level scale. While it can be cheaper if mandated as a default for new built homes and neighborhoods, to compete with the air heat pumps technology in the retrofit projects, the geothermal heat pumps installation costs will need to be reduced to approximately $15,000-$20,000 per home.

#3: Target: Energy Burden.

- **Achieve an X% Energy Burden level for low-income customers:** Many participants, including EDF and UC Berkeley, noted that Energy Burden shall be used across all EPIC programs as a metric for affordability. EDF noted that the US DOE indicates that a typical residential customers' energy burden is approximately 3% of their total income. For low-income customers, the number triples, at approximately 9%. EPIC can help develop Energy Burden targets for California residential and low-income customers that brings it closer to the 3% national average. This metric will help track affordability of EPIC's building decarbonization efforts and their success in making it affordable. CA GND noted the importance of looking at this holistically and systemically with housing affordability and availability and other considerations in mind.
- **Lower electric bills to compete with gas:** Many participants agreed that electrification efforts will not succeed if electricity is more expensive than gas. Participants called for creative ratemaking ideas, including profit share, regulatory asset treatment, utility incentives, redirecting gas upgrades investments to fund electrification, making rates more progressive, or think of using income tax system that is more progressive, to ensure that electric bills stay lower than gas bills. TURN also noted that electric bills increase should be capped at the rate of inflation.

#4: Target: Air Quality.

- **Improve local air quality in most polluted areas**: Many participants noted that, to help target and map out program deployment to prioritize communities that need help the most, all customer-facing programs must include non-energy benefit metrics, such as health, indoor and outdoor air quality, and thermal comfort. This can help target the most polluted areas for low carbon and efficiency upgrades and retrofits to lower energy consumption and displace gas infrastructure buildout with decarbonization solutions that also improve local air quality. EDF stressed that

integrating non-energy benefits, like air quality, into program metrics can provide opportunities for creative rate design solutions. EDF also noted the importance of broadening the definition of "clean" to include both lower carbon footprint and improved local air quality as a critical project outcome.

#5. Target: Building Safety.

- **Increased number of code compliant buildings**: Many participants noted that California's building stock contains a lot of very old buildings, many of which are not up to code. While California has the most aggressive energy requirements in building codes in the country, no adequate funding is designated to bring California's buildings up to those codes. DBC noted that the State and about 75% of Local Building Codes emphasize some form of "electric preferred" or "all-electric" construction. EDF recommended using code compliance as a proxy for the safety metric.

#6. Target: Simple Key Metrics.

Participants also recommended setting simple trackable key metrics, like:

- Cost per kWh;
- % of all-electric buildings;
- % of buildings using distributed solar; and
- % of gas pipeline miles decommissioned.

Unique Role of EPIC

This workshop included additional discussion on EPIC's overall unique role in addressing gaps in pathways. Many participants agreed that, overall, these are the key areas where EPIC has a unique role to play in built environment electrification:

#1: Role: Larger scale deployment and demonstrations.

Many participants suggested that a unique role of EPIC as a ratepayer funded program can be to work on a larger scale, focus on communities and neighborhoods, and use modelling and data analytics to identify key target locations where customers can benefit from deployment the most. For example, this may include areas that have higher quantities of aging gas infrastructure or communities in higher air pollution or weather impact zones. EPIC research can identify how to incentivize and deploy projects at a larger scale, instead of the individual customer level. BDC and RMI noted that the neighborhood-scale approach can provide helpful demonstrations and lessons learned. This approach can also help with aggregation and coordination with gas infrastructure decommissioning, where valuable

lessons can be derived from hard-to-electrify buildings and transitioning entire neighborhoods off of gas service. These lessons can help with scalability and aggregation when expanding programs to more neighborhoods. EPIC can use demonstrations at larger scale as proof of concept by working through different challenges and developing solutions for them. Similarly, RMI suggested research on deploying a larger portfolio of projects at once, e.g., 1,000 or 5,000 buildings, to test benefits and cost savings potential of large-scale deployment. This can help design more sustainable large-scale programs, like utility programs. The Stanford presenter also suggested that larger scale deployment by switching appliances all at once, together, instead of one at a time, at a house, commercial building, and neighborhood level, can provide substantial cost savings. The City of Oakland presenter also noted that deploying equitable solutions at a larger scale can help understand how to target RD&D for the most vulnerable and most impactful areas.

#2: Role: Targeting and reaching the most vulnerable populations.

Many presenters also agreed that one of the key areas where EPIC could help the most with building decarbonization is by targeting areas of the state with the greatest air pollution. They noted that EPIC decarbonization efforts should layer carbon reduction and energy savings targets with local air quality improvement targets when prioritizing program deployment locations. UC Berkeley noted that EPIC research could focus on low carbon appliances and building envelopes, which can help customers in vulnerable populations save money and improve indoor air quality. EDF suggested that EPIC target areas with poor air quality that are also due for gas infrastructure upgrades and deploy decarbonization efforts there to displace gas infrastructure upgrades and, thus, achieve both lower energy bills and improved local air quality.

#3: Role: Develop Energy Burden targets for California.

Many presenters noted that EPIC could play a key role in answering the question of: What is the right level of Energy Burden for California? What number is appropriate for residential, low-income, and other vulnerable customers in the built environment decarbonization efforts? EPIC research could help inform the affordability proceedings and other regulatory and decision-making processes in adopting these metrics and incorporating them across various programs.

#4: Role: Fitting pieces of the puzzle together.

Many presenters suggested that to get to scale all measures discussed in this workshop, including supply side optimization, customer adoption, demand flexibility, gas decommissioning, and financing, need to be stacked together and EPIC's key role in this can

be to identify the order of operations on how to stack different policy goals and measures to fit together. For example, participants suggested coordinating efforts with the Market Transformation Authority on commercialization of technologies that come out of EPIC, coordinating with Advanced Building Construction Collaborative and building departments on retrofit efforts, coordinating with fire authorities on decommissioning gas infrastructure in fire hazard zones, and working with federal programs to find synergies and costs sharing opportunities.

#5: Role: Enable seamless data sharing.

Many participants suggested that EPIC can play a key role in improving data access and data sharing to ensure seamless data flow between consumers, utilities, and aggregators and between different databases and platforms. Participants suggested that EPIC can help navigate how to get different systems and databases across different utilities to export and import data in the right way, how to utilize time series data, and how to ensure access to information with customer privacy protected. For example, AEA noted that utilities have kW draw data for each building, each transformer, and each service drop from that transformer. The National Electric Code allows using 12 months of utility KW draw data to determine buildings' available electrical capacity. Utilities, however, provide this data only to buildings that pay demand charges. AEA noted that having this data will streamline processes as it will demonstrate that NEC calculations for the load of the building overestimate what the total load actually is and may potentially help avoid building upgrades.

Key Gaps

Workshop participants provided the following recommendations for EPIC funded research opportunities that can address key gaps identified during the workshop:

Customer Focused Solutions

Many presenters highlighted that the incentive-based approaches had not worked as expected, particularly for low-income and moderate-income customers, to get to the necessary scale of building decarbonization. The main causes of consumer resistance identified during the workshop included: lack of capital to invest in needed upgrades, lack of time to look for electrification and decarbonization solutions, particularly in emergency replacement situations, and lack of knowledge about available incentive programs and technologies. In general, participants noted that electrification and decarbonization are not within customers' priorities when they look to invest in home upgrades. Another barrier

noted is that many upgrades typically happen in emergency situations, when customers look for the cheapest and quickest solutions and do not have time to investigate cleaner and more efficient alternatives. Contractors that come to perform home upgrades are often not aware of decarbonization solutions and are not trained to sell and install them. Customers that are interested in decarbonization solutions are often dissuaded by complicated incentive programs that are not easy to navigate. Also, customers are often confused by mixed messages that come from political resistance to gas phase-out and related lawsuits.

#1: Gap: Understand customer behavior.

Many participants noted the importance of enabling greater demand flexibility from buildings, including from heating and cooling, light, refrigeration and the EVs and industrial facilities, to support faster and cheaper grid decarbonization. Participants stressed that EPIC could play a key role in studying customer behavior to understand and remove constraints on technology adoption and demand flexibility and improve modelling and forecasting to better account for demand flexibility potential.

- **Potential Role of EPIC:** CDEMC and BDC recommended studying customer behavior and how customers make decisions in adopting electrification and decarbonization solutions, what makes them excited or holds them back, particularly in low-income and ESJ communities, as well as the customer's ability to take on additional debt. CDEMC noted a recent pilot that is studying how people make investment decisions. This study identified 19 criteria, in addition to utility bill reduction, that drive customer decisions. Participants suggested that EPIC could help understand decision making factors and how they differ between customer groups.
- **Potential Role of EPIC:** LBNL suggested that EPIC can be most valuable in identifying behavioral constraints to demand flexibility and ways to balance the need for automation versus customer desire to retain some controls over their energy use. EPIC research can test various key drivers of customer electrification adoption and response to signals in various scenarios of demand flexibility, including small commercial and residential buildings, and energy intensive commercial facilities, like hospitals.
- **Potential Role of EPIC:** LBNL suggested that EPIC research on customer behavior and response to various price and operational signals could be integrated into grid modelling and forecasting. The research can also help improve linkage between grid planning and building modelling to help utilities understand the implications of higher deployment of demand side resources. It could help design technologies and incentives attractive to consumers.

#2: Gap: Incorporate Energy Burden, Air Quality, and Safety metrics into all customer facing decarbonization programs.

Participants noted that all decarbonization efforts must lead to improved Affordability, Clean Energy, and Safety as key indicators of their success.

- **Potential Role of EPIC:** EDF and others suggested that EPIC research could help develop Energy Burden, Air Quality, and Safety targets and metrics and facilitate incorporating them into all decarbonization programs across all utilities and state agencies. EPIC could also help identify how to align utility and customer incentives and reward utilities for effective management and coordination of programs that improve these metrics.

#3: Gap: Improve customer education and outreach.

- **Potential Role of EPIC:** UC Berkeley and CDEMC suggested that EPIC programs could help educate customers and the broader public on decarbonization appliances and retrofits that can help improve indoor air quality and reduce energy bills. UC Berkeley noted, in particular, that EPIC should increase support to community-based organizations that are on the ground in vulnerable communities and can provide customer education, outreach, and technical assistance. These organizations can also help with demonstration projects in the community, considering that adoption of clean energy technology is often a very social and culture-based experience. Often, seeing neighbors adopt decarbonization appliances and receive energy savings and health benefits can help scale up the adoption efforts in the community. BDC recommended studying how customers prefer to receive information and to identify trusted messengers. For example, BDC noted that their survey identified chefs as one of the most trusted voices in the communities and, as a result, started a "Cheffluencer" training program to train chefs on induction technology and demonstrations. The City of Oakland noted examples of the Oakland Eco Block project implementation where working with the communities and designing solutions around community needs lead to greater enrollment and overall project success.

#4: Gap: Develop smart technology workforce and contractor training.

- **Potential Role of EPIC:** UC Berkeley, BDC, CDEMC, SD 350 and many other presenters recommended that EPIC focus on workforce development for smart clean technology installation and maintenance. EPIC could help develop education and training for contractors that are the first point of contact, particularly for emergency repairs, on available appliances, technologies, and incentives. CDEMC suggested that EPIC could

help identify potential sites, organizations, and colleges that can host training programs.

#5: Gap: Financing and simplified access to incentives and programs.

Many presenters highlighted the need for additional financing and easy to access incentives to support customer decarbonization and electrification efforts.

- **Potential Role of EPIC:** To overcome customer resistance, many participants recommended developing a public facing one-stop-shop for decarbonization incentives and financing opportunities so that consumers could understand how to access them. For low-income customers and low-income building owners this resource needs to have human assistance available to help guide them, and not just be an internet-based resource. BDC recommended developing streamlined incentive programs that are stackable with other programs and are easy to access for customers and contractors. BDC noted that easy installation programs for customers that cannot afford upfront costs and affordable financing for customers with low credit scores are also needed. CDEMC suggested that EPIC could help simplify enrollment in the smart device adoption programs to make them easy for customers to sign up and leave, including through automatic enrolment and opt out options.

#6: Gap: Smart rate-design to keep electricity cheaper than gas.

Many participants noted that rate design must ensure that all electric buildings are affordable, and that electricity is cheaper than gas to ensure continuous switching.

- **Potential Role of EPIC:** Participants suggested that EPIC could help navigate potential solutions to advise ratemaking. BDC suggested looking for innovative smart rate design options. SD 350 suggested investigating ways to eliminate or cover utility cost increases in electrification, for example, by tariffed on-bill financing. EDF suggested looking into profit sharing and regulatory asset treatment options.

Buildings Decarbonization and Electrification

Many participants agreed that state funding may not be sufficient to get to the electrification and retrofit scale necessary to reach California's climate goals. One of the key challenges in electrifying multi-family housing is building electric infrastructure upgrades, which can prevent projects from going forward or reduce their scope significantly. Inconsistent standards, interconnection delays and outdated building codes, lack of visibility into the utility systems, and transmission availability further prevent effective design and integration of best suited solutions.

#1: Gap: Leverage private capital to scale up retrofits and decarbonization.

Many participants highlighted a need for innovative solutions to leverage private funding to support state's building decarbonization efforts.

- **Potential Role of EPIC:** Participants noted that EPIC research and demonstrations could build up a factual database for legislators and regulators to adopt solutions and mandates to leverage private funding. For example, one of the solutions suggested by UC Berkeley and EDF was to redirect funding from the gas infrastructure upgrades into helping customers adopt low carbon appliances. The UC Berkely presenter also suggested partnering with larger banks and establishing public private partnerships to leverage public funding that could encourage more private lenders to step in. Another suggestion was to create a microloan marketplace for appliances to ensure that funding is available when needed for urgent repairs and other upgrades. UC Berkeley also suggested leveraging data sharing and smart meter data to identify in advance customer equipment that might need to be replaced soon and inform customers on potential low carbon solutions for these replacements. Another suggestion was to establish a legislative mandate for energy audits and retrofits at the point of sale or lease, similar to the United Kingdom's and New York City's mandates for commercial buildings. This allows customers moving in to understand the carbon and energy footprint of the building.

#2. Gap: Develop more renter ready solutions.

Many participants recommended that EPIC could help develop renter ready solutions that can plug into 120V outlets and help electrify buildings without significant electrical upgrades.

- **Potential Role of EPIC:** AEA and BDC named several technology research opportunities where EPIC could help fully electrify and disconnect houses, particularly multi-family units, from gas services, including:
    - Providing field trials for emerging technologies, such as cooking appliances, domestic hot water and HVAC appliances, with integrated batteries, that allows appliances to plug into 120V outlets on shared circuits. AEA noted that these appliances monitor grid voltages and can adjust and switch off if needed and will be critical to fully disconnect buildings from gas lines.
    - Studying smart panels and addressing fundamental structural challenges with virtual net energy metering (V-NEM) that prevents the use of battery storage and looking into service panel optimization to accommodate more 120V products.

- Testing performance of large central heat pumped hot water systems in extreme climate zones and developing commercial heat pump dryer solutions, lack of which prevents full electrification of multi-family buildings.
- Studying pump chillers that can be used as drop-in replacements for chillers paired with gas boilers for multifamily buildings. Also studying the potential application and performance of the alternative low-global-warming-potential refrigerants that are highly flammable.
- Testing multi-family whole building air leakage.
- Studying combined multi-family mechanical systems.

#3: Gap: Accelerate smart technology adoption.

Participants stressed that smart devices, including grid edge computers, submetering, batteries, smart appliances, etc., face many challenges that must be addressed to accelerate their adoption, including a lack of standardized approaches to data sharing and interconnection.

- **Potential Role of EPIC:** As one of the potential pathways to improve smart device adoption, CDEMC suggested that EPIC continue its work on standardization in coordination with its regional partnerships and with grid operators. This can streamline technology, data, and interconnection standards and codes and can enable technology commercialization and expansion into wholesale markets. Wide enablement of smart devices requires consistency on how these devices are valued on a wholesale market when aggregated. The need for research to help ease interconnection and permitting was also echoed by the City of Okland.
- **Potential Role of EPIC:** CDEMC suggested research into integrating various technologies into utility planning processes and incentive programs and simplifying program enrollment processes.
- **Potential Role of EPIC:** Other areas suggested by CDEMC where EPIC can contribute the most in accelerating smart technology adoption include:
  1) Studying alternative approaches to metering for example, exploring and validating the modified proxy demand resource methodology.
  2) Developing uniform cybersecurity best practices for smart devices.
  3) Developing common open source modeling tools, including data sets, predictive models, and measurement methods that can help engineers predict and manage performance. For example, these tools can help identify and develop new dynamic baselines for load shifting in response to different conditions, like price.

4) Accelerating research, development, and adoption of the distribution system reliability standards and requirements to make it more transparent and easier for new market entrants to understand these standards and navigate different markets.
5) Developing a total system benefits metrics. For example, this may include looking at Pacific Northwest Natural Lab research that starts with the desired "grid of the future" and works backwards to identify the key elements and the order and timeline of issues to be addressed. The research then identifies steps to transition to the "grid of the future" efficiently, in an open and accessible way, and necessary metrics, including certification, standardized reporting, or service level agreements.

#4: Gap: Develop energy performance metric.

- **Potential Role of EPIC:** Participants recommended developing an energy performance metric, for example in air and water heating, to help lower demand and bill impacts of heating electrification and make new high efficiency technologies more affordable and accessible to low-income communities. This can help close the gap in customer adoption of heat pumps and similar technologies and make them more attractive to consumers and more competitive with other technologies.

#5: Gap: Accelerate retrofits through standardized retrofit packages.

Presenters noted that to meet California's climate goals, the retrofit rate must increase 3 to 5 times. RMI shared findings from the REALIZE Initiative that created standardized packages that streamline and standardize retrofit design and delivery. Standardized packages streamline: a) project identification and eligibility through building typology; b) procurement through bulk purchasing; and c) delivery through systematized contractor training. RMI noted that standardized project typology can enable demand aggregation at scale. RMI noted that financing solutions are needed to fund or subsidize the initial cohorts of these projects, and that the Inflation Reduction Act may potentially provide some support but not all that is needed. RMI currently has 4 pilot projects in California and 4 in Massachusetts.

- **Potential Role of EPIC:** RMI suggested that retrofits standardization that accommodates buildings' unique needs through common typologies can provide a solution for scaling up retrofits rate. RMI noted the following key RD&D areas for EPIC to consider that can help accelerate this approach:
    - Setting up a full-suite one-stop-shop solution provider for retrofits that can deliver assessment, design, financing, installation and, potentially, manufacturing.

    - Delivering contractor training and workforce development for these retrofits that ensure diversity and inclusivity and engagement of BIPOC and woman-owned businesses and labor organizations with diverse networks.
    - Developing innovative solutions for air sealing since current solutions are either very manual or disruptive.
    - Developing solutions for retrofit wall panels that pair structural and seismic retrofits with zero-carbon technologies. This may include prefabricated exterior panel products that can provide structural repairs and energy efficiency, or climate-smart wood solutions that can provide alignment with multiple state agencies programs.
- **Potential Role of EPIC:** RMI also suggested coordinating retrofit RD&D with the Advanced Building Construction Collaborative and other research programs to amplify investment and leverage parallel programs, including tapping into federal funding opportunities with EPIC providing cost share.

#6: Gap: Remove building codes restrictions and coordinate with building departments.

Participants noted that building codes often restrict integration of some technologies on shared circuits, even if there is enough electrical capacity in the building. AEA noted that, for example, Packaged Thermal Air Conditioner (PTAC) requires a separate circuit because the Building Codes treat heat pumps as a permanently installed appliance. Air conditioners, on the other hand, are treated as a temporarily installed appliance that can be plugged into shared circuits.

- **Potential Role of EPIC:** AEA noted that it is critical to remove the need for a dedicated circuit for such technology, particularly in multi-family housing, to avoid running multiple additional service lines. EPIC could help coordinate efforts in updating Building Codes to accommodate needs of multi-family housing electrification. EPIC could also help coordinate with the building departments and technology developers, for example, on using smart panel technology to avoid service upgrades and provide demonstrations to get building departments more accustomed to these new proven technologies. The City of Oakland also echoed the need to simplify codes, so it is easier for contractors to follow them and implement various technologies.

#7: Gap: More stress test and experiment-based research for commercial buildings.

Presenters suggested adopting an "experiments first" instead of a "model-first" approach, or, at least, place more emphasis on real world experimentation in RD&D efforts. This is particularly relevant in studying commercial buildings electrification to expedite the transition from planning to implementing solutions. This approach can help generate more data sets for different variations and conditions. For example, Stanford research that adopted this approach identified high efficiency potential from even the smallest temperature adjustments in commercial buildings.

- **Potential Role of EPIC:** The Stanford presenter suggested that EPIC can help generalize this type of experimentation and data driven approach to scale up decarbonization efforts.

#8: Gap: More data-driven and feedback-loop focused research results.

Recurve noted that while California has many demand flexibility and clean energy programs, it is hard to understand what they are delivering and how they are achieving reported results because they lack transparent tracking mechanisms. The energy sector is very data rich, with Advanced Metering Infrastructure (AMI) data and various program models. But many of those models are not as data driven as they need to be.

- **Potential Role of EPIC:** Recurve called for EPIC to ensure that research data is fully available and that programs have embedded measurement verification and analytics that can create feedback loops as the research is progressing, rather than having feedback at the very end of the project. Instead of static reports and fixed savings estimates, or fixed estimates of what the impacts are, it is more valuable to have dynamic feedback loops, where every opportunity and impact of demand flexibility intervention that is being tested can have an actual positive impact on resource planning. Recurve noted that an embedded measurement tracking and verification framework can deliver meaningful results to customers and grid operators. Data-driven models, as opposed to incentive-only models, have the added benefit of providing visibility into potential long term cash flows and return on investments of various technologies to inform and attract private investments. Among the examples of successful data-driven models, Recurve noted the CPUC Distributed Energy Avoided Costs Calculator (ACC) used in the CPUC demand flexibility proceeding (Rulemaking 22-07-005) and the requirement to measure at the meter in the CPUC energy efficiency programs. Recurve noted that the ACC provides a valuable baseline for avoided cost of energy reductions from energy efficiency and demand response programs but can also include any

specific elements, like carbon reduction, localized grid value, and demographic value to calibrate the base value to any specific needs. It provides an opportunity to target various customers and identify those that can benefit or suffer negative impacts from electrification programs, like increased energy bills. Another example is the use of a common measurement and a verification software platform in the market access program. This provides innovators with consistent visibility into the impacts of each project. LBNL also noted that one of the key values of EPIC research is generating missing data that can support future programs and program design. LBNL provided an example of another ratepayer funded program, Tech Clean California, that generated cost data for electrification projects. EPIC could leverage this to keep the barriers to entry low and attract more innovative partners into EPIC programs. This can translate to high impact interventions that provide grid and customer benefits.

#9: Gap: Demonstrate buildings' load flexibility potential in reducing building infrastructure investments.

Presenters noted that the biggest sources for cost savings in large commercial building electrification are the avoided infrastructure investments. Building owners could significantly reduce their capital investments if these buildings are designed to rely on smaller energy infrastructure and load flexibility management, instead of large energy infrastructure.

- **Potential Role of EPIC:** The Stanford presenter suggested that EPIC could help research the physical and behavioral sides of flexible demand management. EPIC could also conduct demonstrations to prove operational efficiency of demand management and build trust around relying on a smaller energy system in commercial buildings with flexible demand capabilities. The Stanford presenter suggested starting with larger buildings of above 5,000 sq. ft. because they have higher emission and energy reduction potential – these buildings are responsible for approximately 92% of building emissions in the US.

#10: Gap: Develop low-cost automation and sensing solutions for commercial buildings.

The Stanford presenter noted the potential value of sensors and automation in decarbonizing commercial buildings. As an example, distributed sensor technology can reveal zone-by-zone energy intensity and flexibility in different rooms and allows for greater efficiency by adjusting heating and cooling in specific zones, rather than the entire room or building.

- **Potential Role of EPIC:** The Stanford presenter suggested funding research on solutions that can make automation and sensing cheaper for commercial buildings. These solutions need to be compatible with legacy systems, need to shorten the hardware and software stack, and need to modernize data management practices to enable scaling up decarbonization efforts.

#11: Gap: Measure unpredictability of commercial buildings demand response.

- **Potential Role of EPIC:** The Stanford presenter recommended evaluating commercial buildings soft and hard energy efficiency and flexibility to measure deviation ranges in buildings' demand response performance. Measured deviations from performance requirements can help grid operators estimate how they can deploy and rely on the buildings' load flexibility services.

#12: Gap: Enable advanced strategic grid planning to help cities and municipalities design their resources more effectively.

The City of Oakland presenter noted that the lack of advanced planning for grid needs and strategic vision of two-way power issues, like vehicle-to-grid or building-to-grid, prevents cities from developing strategies that can support overall electrification efforts. This presenter noted that many interconnection delays could be avoided if there was more visibility into distribution and transmission systems. Resources could be planned accordingly on the local level with all the constraints on those systems taken into consideration.

- **Potential Role of EPIC:** The City of Oakland presenter suggested that EPIC RD&D in this area, in coordination with California Independent System Operator (CAISO), can help inform planning and mapping out where the transmission and distribution problems are, and where there are limitations on transformers, so that cities can design effectively around actual system conditions. AEA also noted that this is a national issue and California can take a lead on this. AEA noted that this is also a permitting and approval issue, particularly when the building owner submits applications to the utilities to add new load, whereas visibility into the grid infrastructure and capacity will streamline a lot of processes by enabling more accurate design and planning.

Coordinated Role of Gas

Participants noted a general concern that customers that are not participating in electrification will be shouldering a greater burden for gas infrastructure upgrades.

Wealthier customers are typically the early adopters of electrification, leaving behind vulnerable populations to carry the increased costs of the gas system. Electrification and building decarbonization programs must be deployed with vulnerable populations in mind. Built environment decarbonization will increase electric usage and electric bills but will displace gas usage, which can create opportunities for innovative ratemaking approaches.

#1: Gap: Displace gas upgrades with efficiency and electrification programs.

Many participants suggested looking into a planned transition for existing gas infrastructure and ways to redirect investments going into upgrades of natural gas infrastructure, that California is trying to phase out, to fund decarbonization efforts as non-pipeline alternatives.

- **Potential Role of EPIC:** Participants suggested that EPIC could investigate options to use electrification, building decarbonization, weatherization, energy efficiency and energy retrofits as the non-pipeline alternatives to displace gas system investments. EPIC could identify areas of the state where gas infrastructure will soon require upgrades and use this approach to retire gas assets instead of upgrading them. Participants highlighted the value of a neighborhood decarbonization approach in utility planning, focused on neighborhoods that need gas upgrades, and redirecting gas upgrades funding to pay for neighborhood-wide electrification. EPIC could help investigate how to coordinate and share data between the utilities across various efficiency, retrofit, and electrification programs, and use these programs as non-pipeline alternatives to displace gas upgrade investments. EPIC could also help navigate how to target these programs with an equity and affordability lens using Energy Burden as a metric. Further, EPIC could investigate how to deploy these programs together and at a neighborhood scale and how to reward utilities for effective management, whether through shared savings mechanisms or some regulatory asset treatment approach, etc.

#2: Gap: Utilize geothermal technology.

Participants suggested looking into using neighborhood or district geothermal networks to switch entire neighborhoods from gas to geothermal heating and cooling and provide opportunities for workforce development.

- **Potential Role of EPIC:** BDC noted that EPIC could help develop targets for California on the necessary scale of the geothermal resources. BDC also noted that California is far behind other states, including New York and Massachusetts, that are already piloting these technologies and getting mandates on targets in front of legislators. EPIC could help test how thermal networks perform in

California (particularly in hot climate zones) and their potential to reduce building load on the grid. EPIC could also help demonstrate potential to reduce water consumption.

- **Potential Role of EPIC:** TURN recommended that EPIC devote funding to advance geothermal heat pump technology. TURN noted that these ground-based heat pumps consume less electricity that results in lower bills and 44% less energy consumption and emissions than air source heat pumps, according to the US Environmental Protection Agency. TURN also noted that the upfront costs of this technology are higher due to drilling, digging, and necessary pipeline infrastructure. EPIC funding could support the development of new digging and drilling techniques that could bring down the costs of installation and retrofit and develop plans to require this technology as a standard for new developments. TURN also named examples of major projects that use geothermal heat pump technology, including the George Lucas Museum and the Los Angeles city-wide project. AEA and BDC echoed the value of mandating this technology for new developments but noted that it can be too expensive for retrofit projects, where air heat pumps are much cheaper, at about $15,000-20,000 per home. Participants agreed that this number can serve as a potential goal for cost reduction for the geothermal heat pump technology for retrofits.

#3: Gap: Fund independent studies on gas decommissioning.

- **Potential Role of EPIC:** TURN recommended that EPIC fund independent studies on how to close and decommission natural gas facilities and develop strategies and a realistic timeline to decommission gas infrastructure as quickly as possible. The City of Oakland speaker noted that gas pipeline rapture poses significant risks for wildfires, particularly in seismic active zones, like Oakland hillsides, and there may be place for coordination of the gas decommissioning and wildfire prevention efforts in those areas, particularly in residential areas, to get multiple benefits and share the costs.
- **Potential role of EPIC:** SD 350 suggested that EPIC could look into system level strategies to reduce ratepayer costs from gas system upgrades, to avoid new gas infrastructure investments and to retire gas infrastructure early. Some suggested research areas include studying opportunities for early retirement of fossil fuel resources through incentives, developing approaches to limit hydrogen to hard-to-electrify uses, and studying approaches to use alternative delivery options to avoid infrastructure upgrades. SD 350 also noted that EPIC could also help with neighborhood and city-wide demonstration projects on gas asset retirement.

#4: Gap: Commercial use of clean hydrogen.

CEC noted the importance of setting safeguards around hydrogen. TURN, on the other hand, recommended that EPIC freeze funding for hydrogen research until clean hydrogen is guaranteed, noting that it is extremely hard to produce because it requires zero emissions though the entire production process. TURN also noted that hydrogen produced with average grid electricity is 65% more carbon intensive than diesel fuel.

- **Potential Role of EPIC:** TURN highlighted the importance of ensuring that hydrogen is produced with a zero-emission footprint and called for EPIC to develop standards to ensure that RD&D funding is only available for 100% clean hydrogen. CBE also emphasized the need to set clear boundaries on what sources of energy can qualify to produce clean hydrogen. CBE recommended that EPIC research help set the scope of hydrogen use as narrow as possible to ensure that when it is being deployed it is not taking place of potential electrification solutions. CBE also noted the need for more clarity on what is required to retrofit the gas system for hydrogen use. The CEC also noted that further research is needed around clean hydrogen use, including understanding the optimal ways to use hydrogen and consider environmental concerns, what safeguards need to be in place, what the important uses are, and how the infrastructure could scale up to support this use. The CEC presenter noted that the CEC is funding an independent study to answer many of those questions, and EPIC could play an important role in researching these issues further.

Equity Considerations

Many participants noted a concern that the most vulnerable customers may end up left behind in the grid decarbonization process while having to pay higher energy bills as they often lack funding, knowledge, and opportunities to be the early adopters of the energy efficiency and low carbon solutions.

#1: Gap: Make building decarbonization technologies more affordable.

Participants noted a shift in building decarbonization RD&D from making technology more efficient to making it more affordable to expedite its adoption but noted that more research is needed in this regard.

- **Potential Role of EPIC:** LBNL suggested that EPIC focus on solutions to significantly reduce costs of higher performing technologies that are entering the market today to make them affordable and accessible to customers and communities that have not traditionally benefited from building technology investments, like the multi-family housing renters.

#2: Gap: Incorporate tenant protections.

CA GND noted that 46% of homes in California are occupied by renters and decarbonization efforts must include tenant protections to avoid higher rent burdens, evictions, and loss of available affordable housing.

- **Potential Role of EPIC:** Participants suggested that EPIC could help develop standards and practices on incorporating tenant protections into decarbonization programs. EPIC could also develop incentives for landlords to drive uptake without sacrificing tenant protections. CA GND suggested that EPIC could help develop approaches to prioritizing housing solutions that are permanently affordable, like community land trusts, and develop strategies to target deed-restricted affordable housing, as opposed to naturally occurring affordable housing.

#3: Gap: Provide whole-home approach in low-income retrofits.

- **Potential Role of EPIC:** Participants suggested that decarbonization and retrofit projects in low-income neighborhoods must be performed in a whole-home approach, with the decarbonization technologies paired with remediations for home safety, energy efficiency, and renewable energy supply. This can reduce the costs of implementation and provide wholistic customer benefits, including energy savings, health, safety, and overall wellbeing.

#4: Gap: Community involvement in hydrogen discussions.

Participants noted concern that a commercial use of hydrogen has a potential to increase infrastructure investments, placing financial burdens on low-income ratepayers while also extending the life of the fossil fuel resources that pollute disadvantaged and ESJ communities. Most vulnerable communities are excluded from the discussions and decision-making process on hydrogen adoption.

- **Potential Role of EPIC:** CBE stressed a need for processes to ensure community participation in hydrogen decision making that allows for community self-determination and protection from perpetuation of “sacrifice zones” in disadvantaged communities that historically hosted gas and fossil infrastructure. There should also be just workforce transition to ensure that jobs are available to the community members and not just outsiders.

Process Recommendations

#1: State and Federal research funding coordination.

Participants suggested coordinating EPIC programs with available federal funding to supplement EPIC funded research and commercialization efforts. EPIC could look for federal funding opportunities to coordinate with EPIC resources to support commercialization, particularly within market-driven federal programs that are more open ended and can support projects in state-identified priority areas.

- **Aim for matching funds and open-ended programs:** SBA noted that federal agencies will typically give a lot of weight to the state's identified priority areas, particularly if supported by matching state funding. As an example, some of the U.S. SBA America's SeedFund programs support small innovative manufacturing and market facilitation in various areas, including cybersecurity, climate science, and clean energy. Typically, SBA's market-driven programs look to invest in technologies to solve problems through commercial marketplace across multiple federal agencies, including the US Department of Energy, US Department of Agriculture, and the US Environmental Protection Agency. These programs are usually more open-ended, without any specific targeted technology, and rely on the applicants to prove how their technology fits into each federal agency's profile and strategic goals.
- **Aim for comparable commercialization timeline**: SBA presenter noted that a US Department of Agriculture survey showed that companies that were successful in commercialization took an average of five years from Phase I award, which is a proof-of-concept stage, to commercialization, and about three years from Phase I to Phase II, which is focused on technology development. The U.S. SBA presenter noted that majority of programs set aside dedicated funding for the Phase I winners to support their future development and these funds are typically available for five years, even if the project was originally market for 1 year funding, before being de-obligated and sent back to the Department of Treasury.

V. APPENDICES

Video Recordings:

Workshop video **Part 1**
Workshop video **Part 2**

Agenda: PDF

Presentations:

Opening remarks: Commissioner Genevieve Shiroma, California Public Utilities Commission (no slides)
Andrew Barbeau, EPIC Policy + Innovation Coordination Group Project Coordinator (no slides)

Roundtable: Customer Focused Solutions.

Elden Hawkes Jr., SBA Office of Innovation and Technology - Presentation Link
Ethan Elkind, UC Berkeley - Presentation Link
Michael Colvin, Environmental Defense Fund (no slides)
Carmen Best, Recurve (no slides)
Joe Desmond, CA Efficiency + Demand Management Council (no slides)
Jared Langevin, Lawrence Berkeley National Laboratory - Presentation Link
Brett Webster, RMI - Presentation Link

Roundtable: Building Decarbonization, Electrification, and the Coordinated Role of Gas

Beckie Menten, Building Decarbonization Coalition (no slides)
Zach Lou, California Green New Deal Coalition - Presentation Link
Andrew Brooks, Association for Energy Affordability (no slides)
Jacques de Chalendar, Stanford - Presentation Link
Kelly Lyndon, San Diego 350 Climate Action – Presentation Link
Daniel Hamilton, City of Oakland - Presentation Link
Theo Caretto, Communities for a Better Environment - Presentation Link
Peter Chen, California Energy Commission - Presentation Link
Mark Toney, The Utility Reform Network (no slides)